Space Weather Technical Forecast

Issued on Thursday, 05 January 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of Moderate solar activity throughout. Chance of G1/Minor Geomagnetic Storm intervals on 05 and perhaps 06 January.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with occasional C-class flares, the strongest of these reaching C9.5 at 04/1845UTC due to a filament eruption in the vicinity of AR3177 and which may have led to a CME. This is one of five regions now on the visible disc, with AR3176 rapidly fading and AR3179 now rotating off the visible disc. AR3180 and AR3181 are both large and developing but are also relatively inactive. A new region is now rotating onto the southeastern limb, which has a history of producing CMEs and significant flare activity from the farside of the Sun. Two CMEs appear to have emanated from the southern hemisphere of the Sun on LASCO C2 and C3 imagery and will be analysed once sufficient imagery becomes available to determine if they are Earth-directed.

Solar Wind / Geomagnetic Activity: Solar wind speeds, observed at L1 started at 450km/s and after a brief decline increased again to 450km/s due to the onset of a CME. Solar winds then declined following the CME passage, falling to just below 400km/s by the end of the period. Density started at a peak of 22ppcc at 05/0125UTC due to the arrival of a CME, then after a brief period of lower density a rear shock produced a peak density of 28ppcc at 04/1400UTC, with values then staying above average. Total magnetic field strength exhibited the signs of a CME passage, with total magnetic field increasing from moderate levels to a maximum of 19nT by 04/0650UTC, and then after a brief decline has maintained moderate to strong levels. The north-south component sharply dropped to -12nT at 04/0153UTC and then slowly returned to a moderate to strong positive polarity by around 04/1400UTC. Phi angle was mainly positive (away from the Sun) until 04/1500UTC and has been mainly negative since. Geomagnetic activity started mainly Active to G1/Minor Storm, with two storm periods between 04/0300-0900UTC, but has since been Quiet to Unsettled.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2MeV) has been at mainly background levels throughout. The 24-hour integrated electron fluence started above the Active threshold but followed a falling trend and reached 3.85e6 integrated pfu by 04/2359UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be mainly Low, but with an increasing chance of both M-class and X-class flares through the forecast period.

Solar Wind / Geomagnetic Activity: The effects of a CME which arrived at Earth on 04 January are expected to subside through 05 January. A further CME may then glance the Earth on 05 or 06 January, but with low confidence. A possible combination of coronal hole high speed streams from coronal holes 60 and 61 are expected to connect with the Earth during 05 January, with speeds estimated to be between 400-500km/s. These speeds are likely to ease slowly by 07 and 08 January. There is a chance of G1/Minor Storms on 05 January, with these again possible on 06 January. A return to Quiet to Unsettled conditions are then possible through 07 and 08 January.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is expected to remain at background levels throughout but with a chance of rising alongside any notable flares, giving a slight chance of exceeding the S1/Minor Storm threshold. High energy electron flux (greater than 2MeV) levels are likely to be suppressed by geomagnetic activity through 05 and 06 January, with an increase then expected as the activity eases. Electron fluence values are forecast to remain below the Active (1e8 integrated pfu) levels for much of the period, with a slight increase in probabilities by the end of the period.

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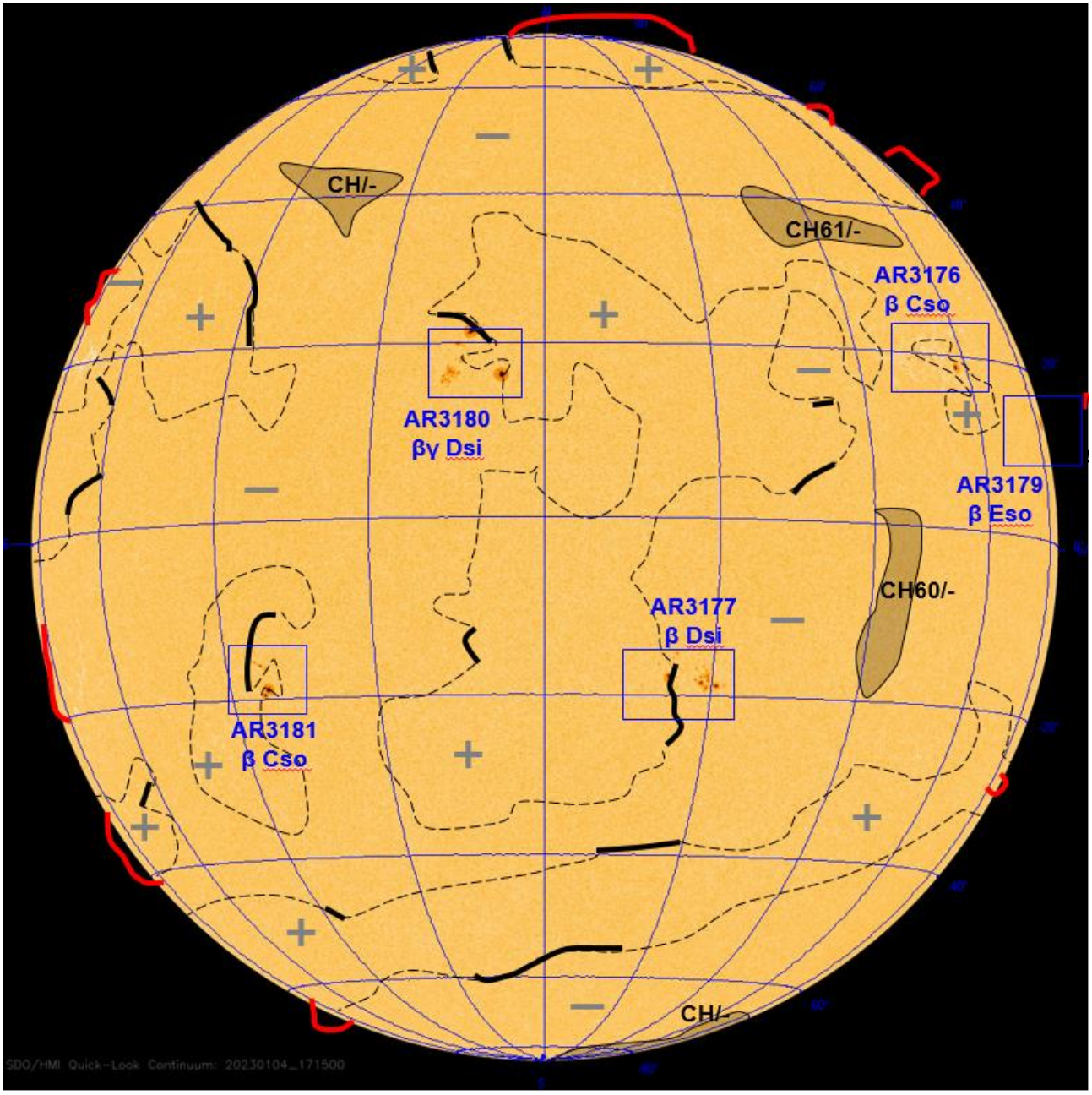
Figure 1. Solar Analysis Valid 04/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
A CME which left the Sun on 30 December passed by the Earth on 04 January with a clear signature observed on L1 data. A further glancing CME impact is possible either late on 05 or during 06 January from a CME which left the Sun on 01 or 02 January, but this appears to be low confidence. A further two CMEs which lifted from south-centre disc during 04 January will be fully analysed once sufficient imagery becomes available.

High speed streams from either coronal holes 60 or 61, or a combination of the two, are due to connect with Earth during 05 January, perhaps later in the day, based on evidence of a recent connection to a feature at STEREO-A, which could either be the coronal hole or a CME. Speeds of 400-500km/s are estimated from these coronal holes, which are much smaller than the equivalent features on the last rotation. These winds are then expected to slowly ease through the remainder of the period.

Chance of G1/Minor Storms on 05 January, with residual effects into 06 January, with a risk of further enhancements from a weak CME during the same period. A gradual return to mainly Quiet to Unsettled conditions are then forecast through 07 and 08 January.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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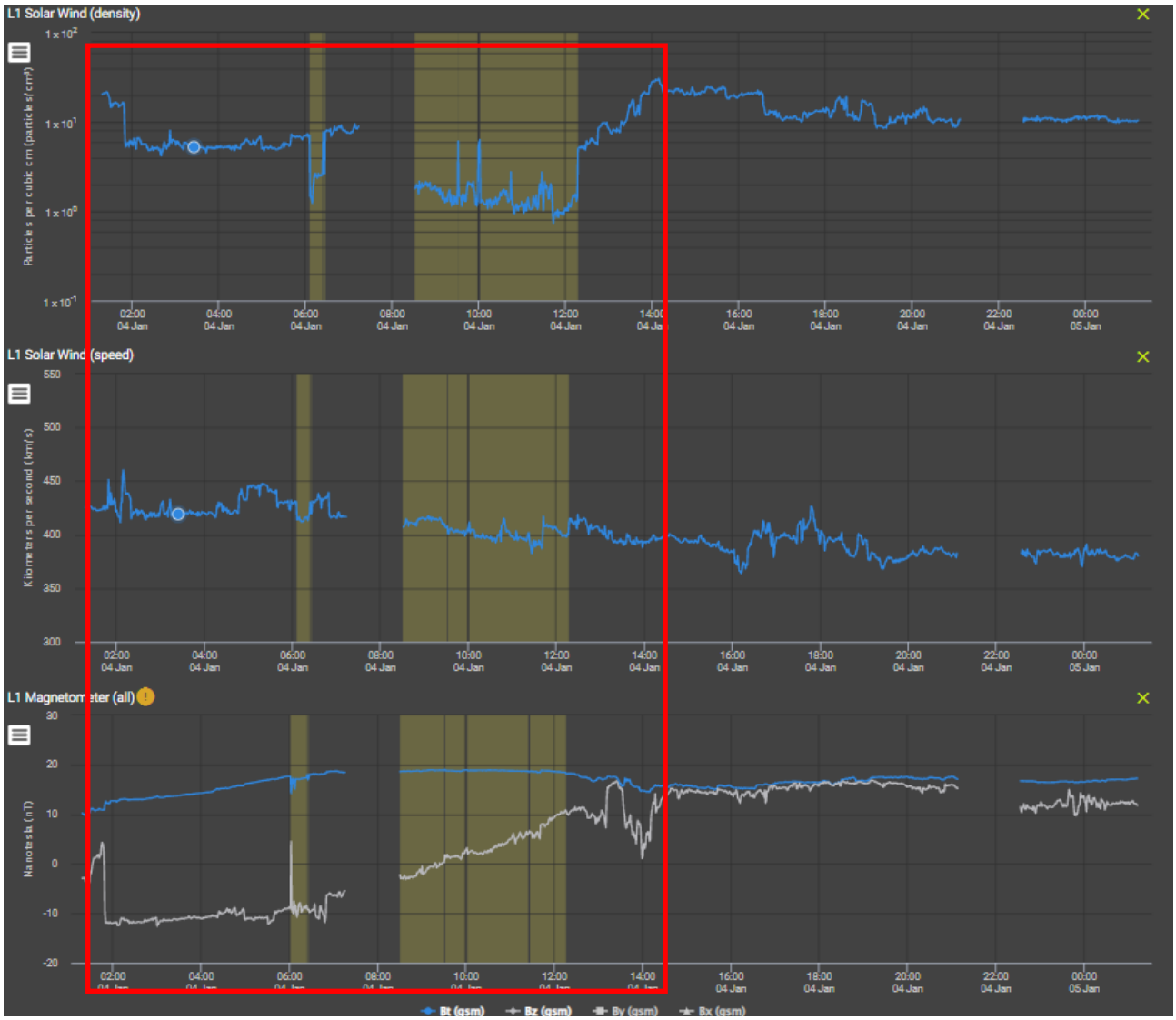
Figure 2: L1 solar wind data from the last 24 hours from both DSCOVR and ACE. The CME signature is highlighted in red.



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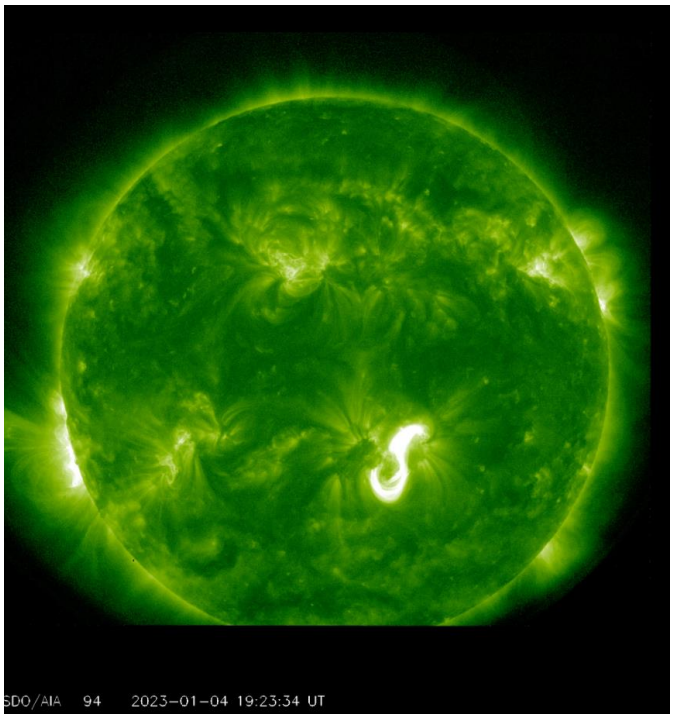
Radio Blackouts - X-Ray Flares:
There are five sunspots on the visible disc, with AR3179 rotating off the visible disc, but with a further region rotating onto the southeastern limb. This new region has been responsible for significant activity on the far side and contributes to the increase in flare probabilities through the period.

AR3177 in the southwest quadrant has been the most active region in the last 24 hours and may have given rise to a CME following a C9.4 flare. AR3176 is fading and is no longer considered a significant flare risk. The remaining regions are all relatively large, but have produced limited flare activity.

Solar activity is expected to be mainly Low, with an increasing risk of M-class and X-class flares, mainly from the new region rotating onto the southeast limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	50	50	50
Very Active	R3 to R5 X Class	No	5	10	10	10

Figure 3: C9.5 flare from the vicinity of AR3177 on SDO AIA 94 imagery. A sigmoid shape is clearly visible.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 is at background levels. Any significant flares will bring a risk of proton flux rising at points during the period, with a slight chance of exceeding the S1/Minor Storm threshold. This risk increases slightly through the period, due mainly to the risk presented by the new region rotating onto the southeastern limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

Electron flux (greater than 2MeV) values have been at mainly background levels due to the recent impact and subsequent geomagnetic enhancements due to a CME arrival. The forecast connection to a coronal hole high speed stream is likely to further suppress electron flux values through 05 and 06 January. An increase is then likely through 07 and 08 January as geomagnetic activity subsides.

Electron fluence is following a sharp downward trend following recent geomagnetic activity. Electron fluence is not expected to now rise above the Active threshold during the period, with a slight increase in probabilities later in the period as geomagnetic activity decreases.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	10	10	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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